

# BEST AVAILABLE COPY

PCT

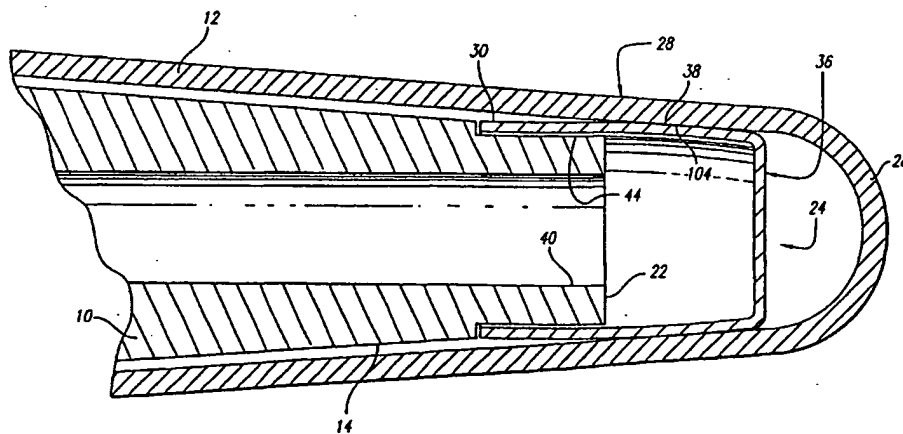
WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification <sup>7</sup> : <b>G01K 1/08</b></p>	<p><b>A1</b></p>	<p>(11) International Publication Number: <b>WO 00/52437</b></p> <p>(43) International Publication Date: 8 September 2000 (08.09.00)</p>
<p>(21) International Application Number: PCT/US00/04953</p> <p>(22) International Filing Date: 28 February 2000 (28.02.00)</p> <p>(30) Priority Data: 09/261,612 28 February 1999 (28.02.99) US</p> <p>(71) Applicant: ALARIS MEDICAL SYSTEMS, INC. [US/US]; 10221 Wateridge Circle, San Diego, CA 92121 (US).</p> <p>(72) Inventor: REDLER, Julie, M.; 457 Parkwood Lane, Encinitas, CA 92024 (US).</p> <p>(74) Agents: RUNK, Thomas, A. et al.; Fulwider Patton Lee &amp; Utecht, LLP, Howard Hughes Center, 6060 Center Drive, Tenth Floor, Los Angeles, CA 90045 (US).</p>		<p>(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p>Published With international search report.</p>

(54) Title: PROBE HAVING A CONVEX-SHAPED TIP FOR USE WITH A MEDICAL THERMOMETER



(57) Abstract

A probe for a thermometer, the distal tip of the probe comprising an axially straight mounting portion and a tapered tubular section with a convex outer surface portion for making increased contact stress with an increased contact surface area with the inner surface of a disposable thermometer probe cover to result in more consistent contact with inner surfaces of disposable probe covers regardless of irregularities in the wall thickness of the probe covers, thereby offering improved heat transfer between the probe cover and the probe regardless of variances among various probe covers.

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

PROBE HAVING A CONVEX-SHAPED TIP FOR USE  
WITH A MEDICAL THERMOMETER

BACKGROUND OF THE INVENTION

The present invention relates generally to medical thermometers, and more particularly to a distal probe tip structure for use with a contact electronic thermometer.

5 Medical thermometers are useful in the diagnosis and treatment of many diseases. It is common practice in the medical arts, as in hospitals and in doctors' offices, to measure the body temperature of a patient by means of a glass bulb thermometer incorporating a heat responsive mercury column that expands and contracts adjacent a calibrated temperature scale. It is also known to use  
10 electronic thermometers that operate to sense the patient's temperature for a short period of time and then extrapolate to predict the actual patient temperature. This latter thermometer results in the determination of a patient's temperature in a much shorter time period than with mercury glass bulb thermometers.

While these thermometers have been used for many years and have been  
15 found to provide useful results in diagnosing and treating patients, some of those who use them desire a thermometer that determines a patient's temperature more rapidly. For example, a mercury thermometer typically takes at least five minutes or more to determine a patient's temperature. An electronic predictive thermometer can take one or more minutes in its predictive mode and five or  
20 more minutes in its monitoring or direct reading mode. Electronic predictive thermometers have become popular because in their predictive mode, the time for taking the temperature is much less than the mercury thermometer. For busy nursing staffs, time is of the essence. Taking a temperature in one minute is much more desirable than taking a temperature in five minutes. More patients can be  
25 served with the faster thermometer and the nursing staff can be more productive.

Additionally, the more time that a probe must be in a patient's mouth to make a temperature determination, the more likely it is that the probe will not remain in the correct location. This is particularly true with younger patients who tend to be impatient. For patients who cannot be relied upon (by virtue of age or

infirmity for example) to properly retain the thermometer for the necessary period of insertion in the body, the physical presence of medical personnel during a relatively long measurement cycle is necessary. Taking a temperature of younger patients in one minute is immensely more desirable than taking the temperature in five minutes. Thus, the predictive electronic thermometer has substantially advanced the art of temperature determination.

In addition to the above, rapid reuse on other patients is also a goal. However, with reuse, precaution must be taken to avoid the possibility of cross contamination between patients. Consequently, protective covers have been designed for use with the probes of thermometers. The protective cover is designed to completely envelope the portion of the thermometer that comes into contact with the patient. Because the protective cover may then be removed after use of the thermometer, and because the protective cover has protected the thermometer from contact with the patient, the thermometer may be immediately reused by simply applying another protective cover.

Protective probe covers have been available for predictive electronic thermometers for many years making the thermometer rapidly reusable when properly used with such covers. However, a protective cover adds material between the temperature sensor in the probe of the thermometer and the heat source; i.e., the patient. Additional material between the patient and the sensor can slow down the process of determining the patient's temperature as heat from the patient must first pass through the probe cover before it reaches the sensor. Gains made in permitting immediate reuse of thermometers due to the use of a disposable probe cover may thus be offset by the increasing length of time it takes to obtain a reading, caused by that same probe cover.

One approach to shortening the time required for a predictive electronic thermometer to take an accurate reading of a patient's temperature is to improve the heat transfer characteristics of the probe and the probe cover. Two main considerations must be taken into account when pursuing this goal: reducing the heat capacity of the probe cover, and improving the flow of heat, or heat transfer, from the patient through the probe cover to the temperature sensor in the probe.

Reducing the heat capacity of the cover can be achieved by selecting a suitable material of construction, although typically low heat capacity materials will also have low heat transfer coefficients. In addition, reducing the dimensions of the probe cover in key areas such as where the probe cover contacts the probe, or  
5 reducing the amount of total material used in manufacturing each probe cover, will also reduce the heat capacity of the probe cover as well as improve the flow of heat through the probe cover to the probe.

In addition, given that each probe cover is used only once and then discarded, it is desirable that such probe covers be as inexpensive as possible.  
10 They should be efficiently produced from readily available, inexpensive materials utilizing common manufacturing techniques. Thus, materials offering good heat transfer characteristics and that are easily injection molded, such as thermoplastics, are desired in fabricating probe covers.

Another consideration in the heat transfer characteristics of a probe cover  
15 is the contact the probe cover makes with the probe tip in which the temperature sensor is located. As is well known to those skilled in the art, air located between a probe cover and the sensor in the probe tip will act as an insulator and will slow down the transfer of patient heat to the sensor. It will then take longer to obtain a measurement of the patient's temperature. Consequently, most probe and probe  
20 cover systems are designed and configured to achieve contact between the tip of the probe, where the temperature sensor is located, and the inside surface of the probe cover so that patient heat is transferred more quickly to the temperature sensor. Where the inside surface of the probe cover is smooth but the outside surface of the probe tip is relatively rough, heat transfer will be adversely affected.  
25 Creating greater contact stress, i.e., stress between the tip and the probe cover when they are mounted together, will cause the smoother inside surface of the probe cover to better contact the rougher surface of the probe, thereby transferring more heat faster. Thus, creating a higher contact stress level is desired in such situations.

30 A further consideration is the size of the contact surface area between the probe tip, within which the sensor is mounted, and the probe cover. The larger

the surface area, the faster heat from the patient can be transferred from the probe cover to the sensor. Typically, a probe placed in a patient's mouth has a large contact surface area at the tip of the probe with tissues of the mouth. Thus, a large amount of heat immediately is applied to the probe cover. However, if  
5 there exists only a small contact surface area between the probe cover and the probe tip, the transfer of heat from the patient's tissues to the sensor will be slowed considerably. This will in turn slow down the determination of the patient's temperature. Increasing the size of the probe tip will permit more surface area and the better transfer of heat to the probe tip from the probe cover.  
10 However, a larger probe tip also results in a larger thermal mass which will dissipate the heat before it reaches the internal sensor. Thus a probe tip with a larger surface area, but not too large a surface area is desirable.

In a prior probe tip configuration, the tip was shaped so that when it is jammed into the probe cover, it would achieve a wedge-type of contact with the probe cover. U.S. Pat. No. 4,343,185 to Knute, for instance, discloses a probe  
15 with a generally cylindrical sensor tip that is force fit within a cone shaped cover manufactured from a somewhat flexible material that yields to the probe tip and expands around it. While this probe provided a distinct advance in the art, unfortunately, variances in the wall thickness of the probe cover tend to  
20 compromise the continuity of the fit between the cover and the probe tip. In many cases, the probe cover thickness can vary greatly at the distal tip due to inherent variances in the molding process of the probe cover. Eliminating such manufacturing variances would be prohibitively costly such that probe covers would be rendered too expensive to be practical. Thus, if possible, it is preferred  
25 to contact the inside surface of the probe cover at locations proximal to the distal tip.

Hence, those skilled in the art have recognized a need for an improved thermal interface between a temperature probe in which a temperature sensor is located and inexpensive, disposable probe covers to enable more rapid, accurate  
30 measurements of a patient's temperature. Additionally, those skilled in the art have also recognized a need for a larger surface area of contact between the probe

tip and a probe cover to achieve faster energy transfer between the probe tip and the probe cover. Furthermore, those skilled in the art have recognized the need for a probe tip design that automatically achieves a larger surface area of contact with probe covers having varying shapes and thicknesses of material. The  
5 invention fulfills these needs and others.

#### SUMMARY OF THE INVENTION

Briefly and in general terms, the present invention is directed to a probe having a convex-shaped tip for a thermometer, the probe comprising a probe shaft and a distal tip that encloses a temperature sensing element. In one aspect, the  
10 distal tip is shaped for more consistent contact with disposable probe covers mounted on the probe. In a more detailed aspect, the probe tip in accordance with the invention includes a convex portion having a size larger than the inner diameter of probe covers used with the probe such that increased contact stress exists with increased contact surface area.

15 In a further aspect in accordance with the invention, the distal tip of the probe comprises a shaped metal tip mounted to the probe shaft, the metal tip enclosing the sensing element. The probe shaft being formed of a non-metallic material that is a poor heat conductor. The shape of the metal tip includes the convex shape designed to optimize the contact with the inner wall of a probe  
20 cover, and thus optimize the flow of heat between the probe cover and the tip.

In yet a further aspect, the distal tip is of a generally cylindrical design with a proximal end for receiving the distal end of the probe shaft and for mounting on that distal end, a closed distal end of smaller diameter than its proximal open end, and a gently curved convex surface tapering therebetween.

25 In another more detailed aspect of the present invention, a distal probe tip is provided to be attached to the distal end of a temperature probe shaft and enclose a temperature sensor. The tip has a generally tubular structure with a proximal open end to receive the shaft of the probe for mounting thereon and a closed distal end. The tip is hollow as is the shaft of the probe. The temperature  
30 sensor is mounted in the distal tip and wires connected to the temperature sensor

are located in the hollow distal tip as well as through the hollow probe shaft. The wall of the distal tip structure tapers from a substantially cylindrical mounting portion to an inwardly tapered, conical portion sloping towards the closed distal end. The wall surface of the tapered portion of the distal tip is formed with a  
5 gentle convex curvature that receives a probe cover thereupon and, due to its curvature and its size, provides improved contact with probe covers compensating for variances in the thickness of the probe covers and for variances in inner diameters.

These and other aspects and advantages of the invention will become  
10 apparent from the following detailed description and the accompanying drawings, which illustrate by way of example the features of the invention.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a side view showing a thermometer probe and probe cover assembly incorporating a probe tip in accordance with aspects of the present  
15 invention;

FIG. 2 is a cross-sectional side view of the outer housing of the distal tip of a thermometer probe shown in FIG. 1 and in accordance with aspects of the present invention, wherein the internal components of the probe have been removed for clarity of illustration;

20 FIG. 3 is a cross-sectional view of the tip depicted in FIG. 2 looking along the longitudinal axis in the distal direction and wherein, as in FIG. 2, the internal components of the probe have been removed for clarity of illustration; and

FIG. 4 is a cross-sectional side view of the tip of a disposable probe cover in contact with the thermometer probe tip depicted in FIG. 2 which is mounted on  
25 the distal end of the shaft of the thermometer probe shown in FIGS. 1-3.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning now to the drawings, in which like reference numerals are used to designate like or corresponding elements among the several figures, in FIG. 1 there is shown a thermometer probe 10 and probe cover 12 assembly in



accordance with aspects of the present invention that comprises an elongated thermometer probe shaft 14 mounted to a probe housing 16 and an electric cable 18 extending from a temperature sensing element disposed within the distal tip of the shaft (not shown) through the shaft and housing to the data processing  
5 portion of the thermometer [also not shown] for measuring and displaying the temperature sensed by the temperature sensing element. The shaft 14 includes a proximal end 20 mounted within the housing 16 and a distal end 22 with the probe tip 24 mounted thereupon. The elongated probe cover 12 is shaped and sized to fit over the probe shaft 14 and includes an open end 26 to accept the  
10 probe shaft into the probe cover and a distal tip 28 to fit snugly and securely over the probe tip 24.

With greater detail, and referring now to FIG. 2, a probe tip 24 in accordance with aspects of the present invention is shown and consists of a thin sheet of material 28 defining a generally tubular structure comprising an axially  
15 straight, or cylindrical, section 30 and a tapered portion 32. The tapered portion 32 has a large open end 34 contiguous with the straight portion 30 and a closed or small end 36. The tapered section 32 is further formed with a slightly convex outer surface 38.

As shown in FIG. 2, the probe tip 24 may be formed homogeneously  
20 comprising both the axially straight portion 30 and the tapered portion 32 with the closed end 36 such as by machining from a solid rod of material. Alternatively, the end 36 of the tip may comprise an end cap that may be welded to the small end of the tapered portion 32. In one preferred embodiment, the entire probe tip 24 is screw machined from round aluminum stock.

25 To improve the heat transfer characteristics of the probe tip 24, the thickness of the material 28 including the end 36 should be kept to a minimum, because any material would act as a heat sink and a thicker tip would absorb more heat than a thinner one, thus slowing down the time necessary for heat to travel from the patient through the tip to an internal temperature sensor.  
30 Therefore, the material chosen for manufacturing the probe tip 10 should ideally be structurally strong, a good conductor of heat, such as aluminum or stainless

steel, and be compatible for internal use on humans. A preferred material of construction is 2024-T4 aluminum.

It should be noted that a balance has been made between obtaining a large surface area of contact between the tip and the inside of the probe cover, and the mass of the probe tip. A large surface area of contact is desirable as such permits larger amounts of heat energy to reach the probe tip faster. However, a large surface area of contact can mean a large tip mass. Because the tip is formed of a material that conducts heat well, it will act as a heat sink, and if the mass is too great, the tip material will actually slow down the heat measurement process. On the other hand, a small tip with a small surface area of contact will slow down the transfer of heat from the probe cover to the sensor inside the tip thus also slowing down the heat measurement process. Thus a balance must be formed.

For the reason outlined above, the overall preferred dimensions of the tip 24, as described elsewhere in the specification, have been chosen to provide an optimum balance to obtain rapid temperature measurement. In reaching those dimensions, the size of the mounting portion of the tip must be considered as it is likewise formed of a good heat conductive material and will act as a heat sink. While the mounting portion must be long enough to obtain a firm mount of the tip to the shaft, it should be kept as small as possible.

The probe cover 12 should ideally be formed from an inexpensive material that is easily formed into the probe cover shape. Furthermore, the material should be somewhat pliable so that it will deform to the tip shape when mounted to the probe. A preferred material of construction of the probe cover is polyethylene.

With reference now to FIGS. 1 and 4, in use the probe tip 24 of the present invention is mounted on the distal end 22 of a temperature probe shaft 14 and secured thereto by any known means, including bonding by heat conductive adhesives. The temperature probe 10 typically consists of a shaft 14 with a lumen 40 extending therethrough, a thermistor 42 or other sensor disposed at a closed end 36 of the tip 24 and in thermal contact with the inside of the probe tip 24, and electrical leads running through the lumen 82 for connecting the thermistor

to the signal processing portion of the electrical thermometer (for clarity, the electrical leads are not shown in the drawings).

With continued reference to FIG. 4, in a typical embodiment the probe shaft 14 is generally cylindrical and has a tapered distal portion formed with a cylindrical outer surface 44 to receive the proximal cylindrical portion 30 of the probe tip 24. The use of adhesive, which is typically applied in a liquid state between the probe surface 44 and the cylindrical portion 30 of the probe tip 24, ensures a good structural bond despite any surface irregularities present in either of these two elements. The probe tip 24 is thus permanently mounted to the distal end of the probe shaft 14 with the cylindrical portion 30 overlying the cylindrical probe shaft surface 44, which is formed on the distal portion of the probe shaft 14 just for this mounting purpose.

With continued reference to FIGS. 1 and 4, prior to use of the probe 10, a probe cover 12 is mounted upon the probe 10 to enclose the probe shaft 14 and thus prevent the probe shaft from coming into contact with the patient's body or bodily fluids, such as saliva or blood. The probe cover 12 has a shape similar to the probe shaft 14, with a tubular, slightly tapered body and a rounded distal tip 27. The probe cover is meant to easily fit over the probe shaft 14 and be held in place with a retaining mechanism, not shown. As is seen in FIG. 4, the inner diameter of the probe cover is larger than the outer diameter of the probe along the probe shaft 14. However, contact between the probe cover 12 and the probe 10 at the tip 24 is necessary for good thermal transfer. Preferably, the sole points of contact between the probe cover 12 and the probe 10 are at the probe tip 24 (other than mounting contacts which may occur at the proximal end of the probe, not shown) in order to concentrate to the maximum extent possible the heat transferred from the probe cover to the probe in the area containing the temperature sensor and minimize dissipation of heat to any other areas of the probe. Such a configuration thereby shortens the time required for the sensor to obtain an accurate reading of the patient's temperature.

The probe cover 12 is thus the sole element to come in contact with the patient's body thus protecting the probe and permitting its instant reuse with

another probe cover and another patient. However that probe cover presents a barrier to heat transfer from the patient to the temperature sensor 42 in the tip 24. As discussed above, good heat transfer between the probe cover 12 and the probe 10 is essential to obtaining a rapid and accurate reading of the patient's temperature. Thus, by contacting the probe 10 solely at the probe tip 24 where the sensor is located, there will be less dissipation of the patient's heat and the probe cover 12 will more quickly transfer the patient's heat to the thermistor (sensor) disposed within the tip. The shape of the tapered section 32 of the probe tip 24 is therefore designed to fit within the probe cover 12 adjacent the probe cover distal tip 27, and the probe cover 12 is dimensioned so as to contact the probe tip 24 solely at this tapered section 32.

Furthermore, the convex outer surface 38 of the probe tip 24 ensures a tight, consistent fit between the inner surface of probe cover 12 and the tip 24 regardless of variations or irregularities in the wall thickness of the probe cover. This occurs because the curved surface 38 will always have one portion along its curvature that has a slope equal to that of the inner surface of the probe cover 12 and that portion will contact the inner surface of the probe cover providing a large surface area of contact between the two. This convex surface 38 approach provides a distinct advantage in that good contact between the probe cover and the probe tip will exist because the diameter of the section of the probe tip having the convex surface is larger than the inner diameter of the probe cover. Thus an interference fit is assured with increased contact stress due to the difference in diameters between the convex portion and the inner diameter of the probe cover. The probe tip 24 of the present invention is therefore designed to compensate for irregularities in a probe cover 120 and to increase the thermal transfer from the patient's tissue to the probe tip by increasing the contact area and contact stress between the tip and the cover.

To maximize the contact surface area between the probe cover 12 and the probe tip 12, the curvature of the convex tip outer surface 38 is formed with only a relatively slight degree of curvature. Furthermore, the actual shape of the convex outer surface 38 may vary and may include an arc of an oval, an arc of a

circle, or even have varying degrees of curvature along its length and/or circumference. In a preferred embodiment, however, the probe tip 12 is formed with a convex outer surface 38 in the shape of an arc of a circle having a radius of about one inch to about four inches, and more preferably having a radius of one  
5 inch.

Additionally, the slightly curving nature of the tip automatically compensates for inner shapes of probe covers that may be at different angles. The convex surface 38 is highly likely to contact these shapes. Prior approaches, such as the one discussed in the background section where a jam fit is used, make use  
10 of a taper on the inner surface of the probe cover and a taper on the outside of the probe tip. If these tapers are complementary, good contact will result. However in the case where the inside surface of the probe cover varies, good contact may not be established and only a point contact may occur resulting in a greatly reduced surface area with slower measurement response time.\*\*\*

15 Manufacturing the tip 24 with a highly arced outer surface is not an ideal solution either, because even with a perfectly formed probe cover 12, the inner surface of the cover will only be able to contact the tip along a very narrow band between the barrel-like surface of the tip and the straight or nearly straight tapered planar inside surface of the cover. The variations that may be  
20 encountered in probe covers only exacerbate the problem by not allowing the cover to contact the tip along the entire circumference of this already too-narrow band. It has been found that the embodiments disclosed above result in the best heat transfer between the probe cover and the tip.

A further advantage provided by the convex outer surface 38 of the probe  
25 tip 24 of the present invention lies in the location of the contact surface between the tip and the cover, which is typically about the middle of the convex surface or toward the open end 34 of the tip. This is advantageous because, due to the manufacturing process employed, the largest degree of variation in the cover wall typically occurs near the distal cover tip 28. Therefore, to achieve optimal heat  
30 transfer between the probe tip and the probe cover, the contact area between the tip and the cover should ideally be situated away from this zone of maximum

variance in the probe cover. The slightly convex surface 38 in accordance with FIG. 4 overcomes these problems that occur with prior art probes.

The probe tip of the present invention therefore allows the probe cover to be manufactured within relatively loose tolerances that result in significant cost savings. The tapered section 32 with the convex outer surface 38 of the probe tip 24 thus provides a great improvement in the quality of contact stress between the tip 24 and the probe cover 12, as well as minimizing the amount of force necessary to ensure a good fit between the tip and the cover.

The quality of the contact between the tip and the probe cover can further be improved by manufacturing the tip 24 with a smooth outer finish. In one embodiment, the finish on the probe tip 24 is a no. sixteen finish, which has been experimentally verified to provide a preferred balance of sufficiently high contact area between the tip and the probe cover 12, and acceptable tip and cover manufacturing costs. Although a no. sixteen finish is not an optimally smooth finish and is typically rougher than the finish on the inside surface of the probe cover 12, the polyethylene material from which the cover is manufactured is sufficiently pliable to mold itself to a certain extent around the probe tip 24 as the user seats the cover onto the tip and thus create a sufficiently large surface area of contact between the cover and the tip convex outer surface 38 to promote rapid heat transfer from the probe to the tip.

The dimensions of the device shown in the figures will vary as required by the size of the temperature probe with which the probe tip 24 is to be used, the size and shape of the temperature sensing element 42 that is to be disposed within the tip, and the size and shape of the probe cover 12 intended for use with the probe 10. In one preferred embodiment, the cylindrical portion 30 of the probe tip 24 has an inside diameter of about 2.87 mm (0.113 inches) to about 2.97 mm (0.117 inches), and preferably 2.92 mm (0.115 inches). The wall thickness of the cylindrical portion 30 and the tapered portion 32 is about 0.127 mm (0.005 inches) to about 0.178 mm (0.007 inches), but preferably the end is about 0.178 mm (0.007 inches) thick and the cylindrical section and the tapered section are both about 0.127 mm (0.005 inches) thick. The overall length of the probe tip

10 is about 3.05 mm (0.120 inches) to about 3.3 mm (0.130 inches) but preferably is 3.25 mm (0.128 inches), and the axial length of the cylindrical portion 30 of the probe tip is about 1.143 mm (0.045 inches) to 1.40 mm (0.055 inches) but is preferably about 1.25 mm (0.049 inches). In one embodiment, the  
5 convex surface 32 comprises an arc of a circle with a radius of curvature of about 25.4 mm to 101.6 mm (1 to 4 inches) but preferably 25.4 mm (1 inch). The diameter of the end is about 2.85 mm (0.112 inches) to about 2.89 mm (0.114 inches), but preferably is about 2.87 mm (0.113 inches).

In view of the foregoing, it is apparent that the device of the present  
10 invention significantly improves the heat transfer characteristics between a temperature probe and a temperature probe cover in an easily implemented, inexpensive manner, thereby increasing the speed and accuracy, as well as the hygienic safety, of electronic thermometers. Further modifications and improvements may additionally be made to the device and method disclosed  
15 herein without departing from the scope of the invention. Accordingly, it is not intended that the invention be limited, except as by the appended claims.

What is claimed is:

1. A thermometer probe for a medical thermometer, the probe being for use with a disposable probe cover, the thermometer probe comprising:  
an elongated shaft for insertion into the probe cover, the shaft having a distal end; and  
5 a tip located at the distal end of the shaft, the tip having a convex outer surface portion having a size selected to be larger than an inner surface of the probe cover whereby contact is established between the convex surface and the inner surface of the probe cover when the probe cover is mounted on the elongated shaft.
2. The thermometer probe of claim 1 wherein the convex outer surface comprises the shape of an arc of a circle.
3. The thermometer probe of claim 2 wherein the arc of a circle has a radius of curvature ranging from about 2.54 cm (1 inch) to about 10.16 cm (4 inches).
4. The thermometer probe of claim 1 wherein the tip is formed from a biologically compatible material.
5. The thermometer probe of claim 4 wherein the tip is formed of aluminum.
6. The thermometer probe of claim 1 wherein the tip comprises a mounting portion at a proximal end, the mounting portion configured to receive the distal end of the elongated shaft to which the tip is located.
7. The thermometer probe of claim 1 wherein the diameter of the convex portion of the tip is larger than a diameter of the inner surface of the



probe cover and is selected such that when the probe cover is mounted to the probe tip, increased contact stress and increased contact area exists between the convex portion and the probe cover.

8. The thermometer probe of claim 1 wherein the tip comprises:  
a substantially cylindrical mounting portion formed to receive the distal end of the probe shaft within the mounting portion to attach the tip to the probe shaft;
- 5 a convex portion having a diameter selected such that the convex portion contacts the inner surface of the probe cover; and  
a closed end.
9. The thermometer probe of claim 1 wherein the tip axial length ranges from about 0.12 inches to about 0.13 inches.
10. The thermometer probe of claim 1 wherein:  
the tip comprises a mounting portion that is substantially cylindrical in shape for receiving the distal end of the elongated shaft;  
the tip comprises an angled portion with a generally tapering outer surface  
5 oriented such that the larger end is proximal and the smaller end is distal with the distal end being closed; and  
the angled portion includes the convex portion.
11. A thermometer probe for a medical thermometer, the probe being for use with a disposable probe cover, the thermometer probe comprising:  
an elongated shaft of a plastic material having a low heat conductivity, the shaft configured for insertion into the probe cover, the shaft having a distal end;  
5 a tip located at the distal end of the shaft, the tip comprising:  
a mounting portion within which is received the distal end of the plastic probe shaft thereby attaching the tip to the probe shaft;

10           a convex outer surface portion distal to the mounting portion and having a shape of an arc of a circle and having a size selected to be larger than a diameter of an inner surface of the probe cover such that when the probe cover is mounted to the probe tip, increased contact stress and increased contact area exists between the convex portion and the probe cover; and

          a closed end.

12.   The thermometer probe of claim 11 wherein:  
the mounting portion is substantially cylindrical; and  
adhesive exists between the mounting portion and the distal tip of the probe shaft such that the tip is fixedly mounted to the distal end of the probe shaft.

13.   The thermometer probe of claim 11 wherein the arc of a circle has a radius of curvature ranging from about 2.54 cm (1 inch) to about 10.16 cm (4 inches).

14.   The thermometer probe of claim 11 wherein the tip is formed from a biologically compatible material.

15.   The thermometer probe of claim 12 wherein the tip is formed of aluminum.

16.   A probe tip for the probe of a medical thermometer, the probe having an elongated shaft for insertion into a disposable probe cover and the shaft having a distal end, the probe tip comprising:

5       a mounting portion adapted to connect to the distal end of the shaft to mount the probe tip thereto;

          a convex outer surface portion having a size selected to be larger than a diameter of an inner surface of the probe cover and selected such that when the

probe cover is mounted over the probe tip, increased contact stress and increased contact area exists between the convex portion and the probe cover.

17. The probe tip of claim 16 wherein the convex outer surface comprises the shape of an arc of a circle.

18. The thermometer probe of claim 17 wherein the arc of a circle has a radius of curvature ranging from about 2.54 cm (1 inch) to about 10.16 cm (4 inches).

19. The probe tip of claim 16 wherein the mounting portion comprises a substantially cylindrical portion adapted to receive the distal end of the probe shaft to attach the tip to the probe shaft, and the probe tip further comprising a closed distal end.

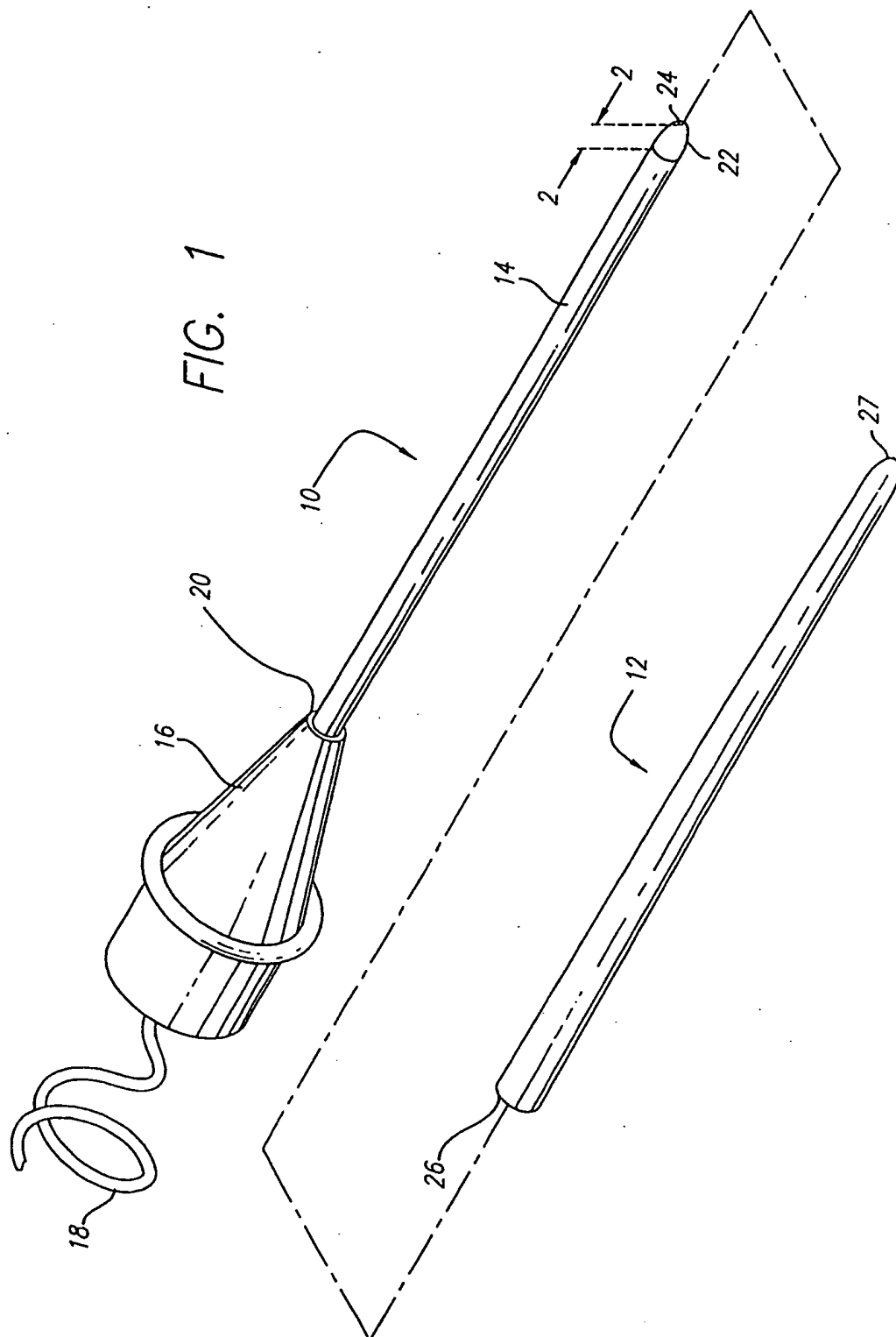
20. The thermometer probe of claim 16 wherein the tip is formed from a biologically compatible material.

21. The thermometer probe of claim 20 wherein the tip is formed of aluminum.

22. The thermometer probe of claim 8 wherein the mounting portion is about 1.143 mm (0.045 inches) to 1.40 mm (0.055 inches) long.

23. The thermometer probe of claim 5 wherein the tip is formed with a wall thickness of about 0.127 mm (0.005 inches) to about 0.178 mm (0.007 inches).

1/3



2/3

FIG. 2

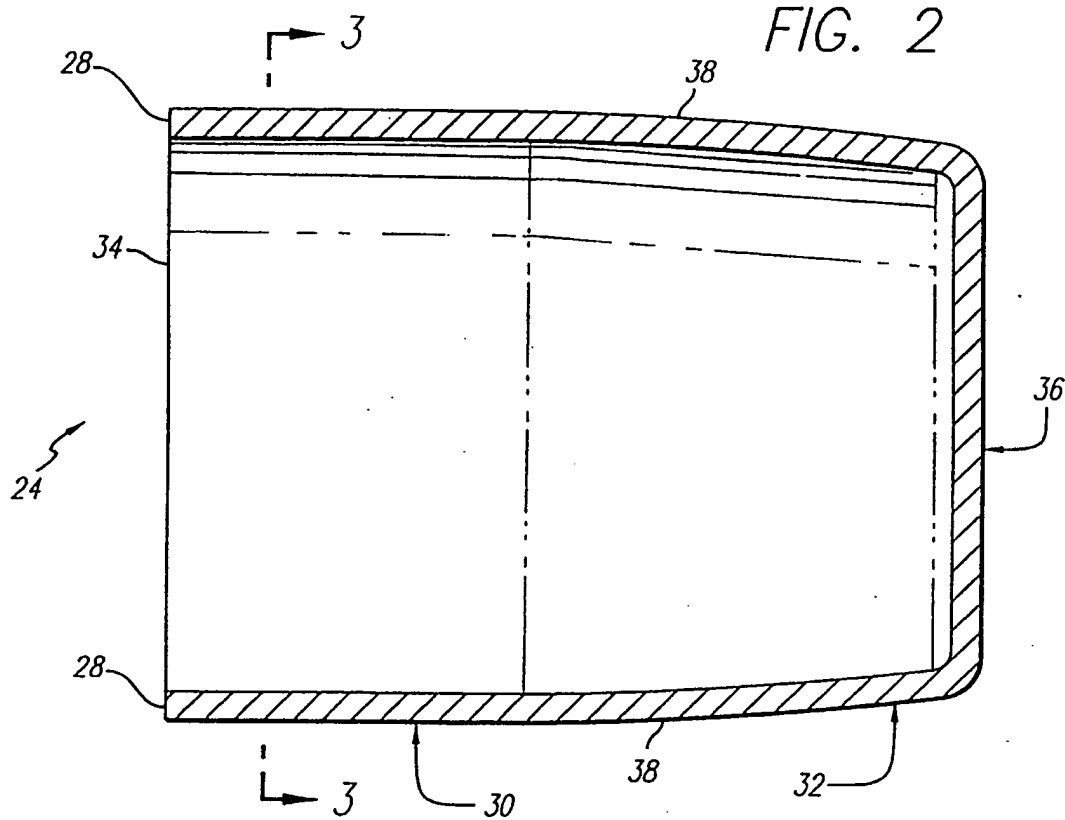


FIG. 3

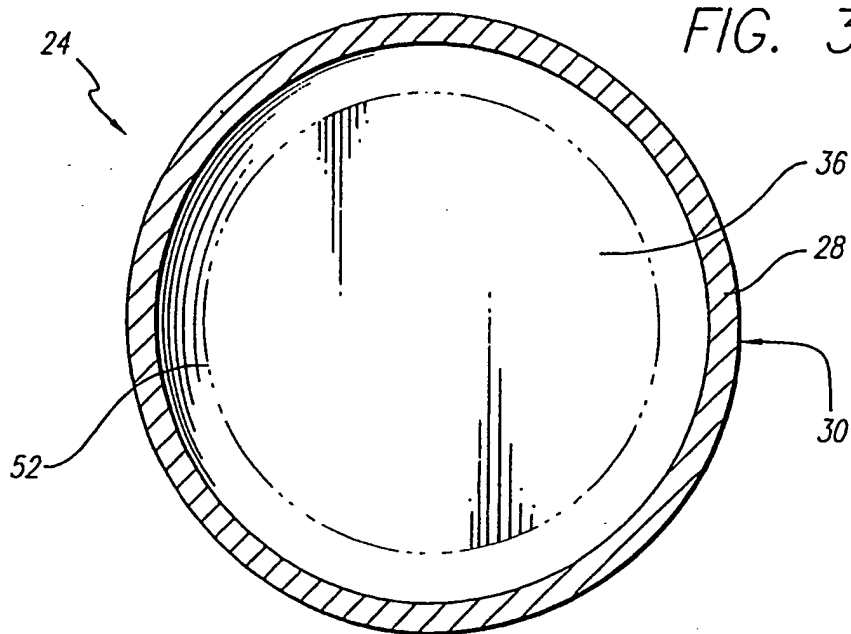
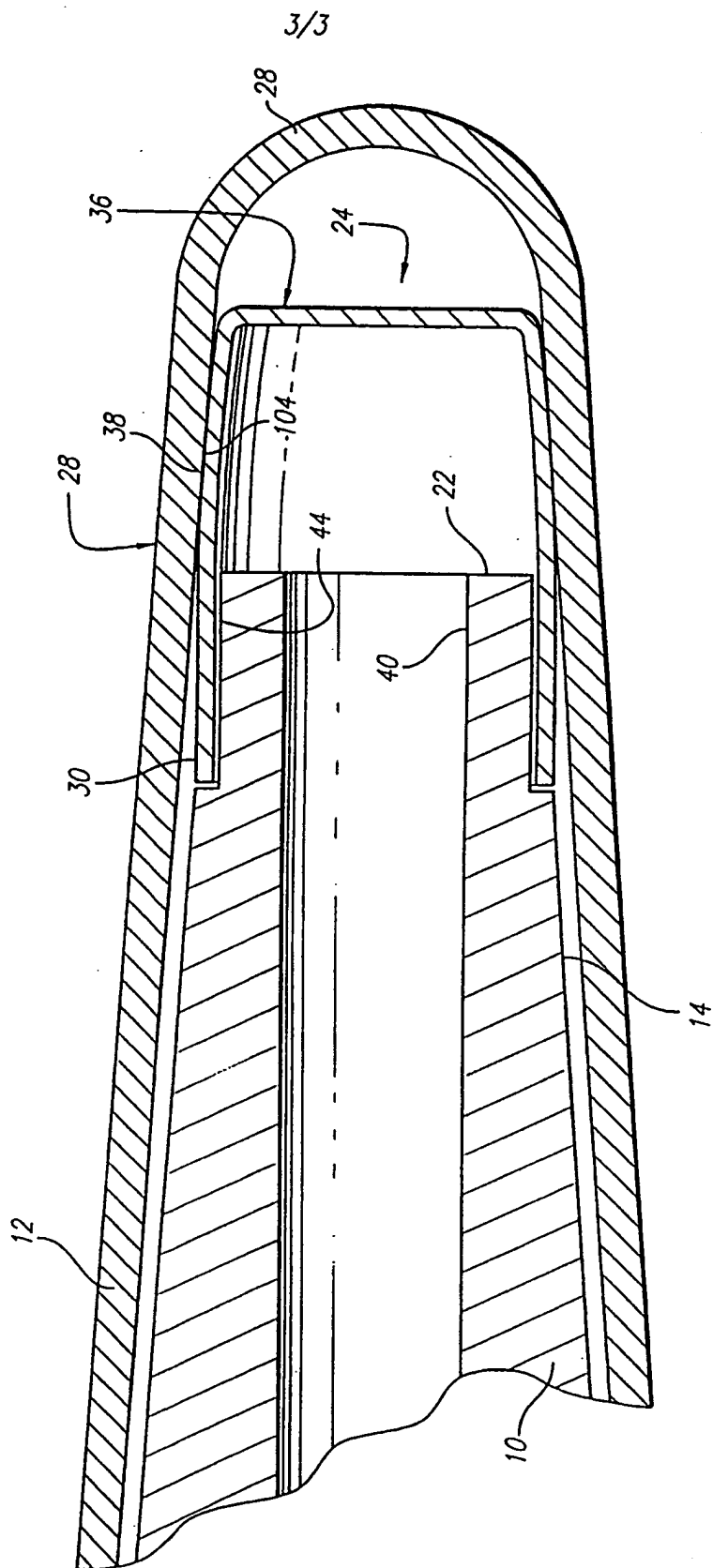


FIG. 4



# INTERNATIONAL SEARCH REPORT

Inter. Appl. No.

PCT/US 00/04953

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G01K1/08

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G01K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 159 766 A (KLUGE DOUGLAS J) 3 July 1979 (1979-07-03) column 4, line 1 - line 23; figures	1, 11, 16
A	column 1, line 27 - line 30 ----	4, 5
A	US 4 343 185 A (KNUTE WALLACE L) 10 August 1982 (1982-08-10) cited in the application figures 3, 4 -----	1, 11, 16

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

### \* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

27 April 2000

Date of mailing of the international search report

08/05/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Ramboer, P

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 00/04953

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4159766 A	03-07-1979	NONE	
US 4343185 A	10-08-1982	CA 1150972 A FR 2448714 A	02-08-1983 05-09-1980



**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

**BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☒ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☐ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**